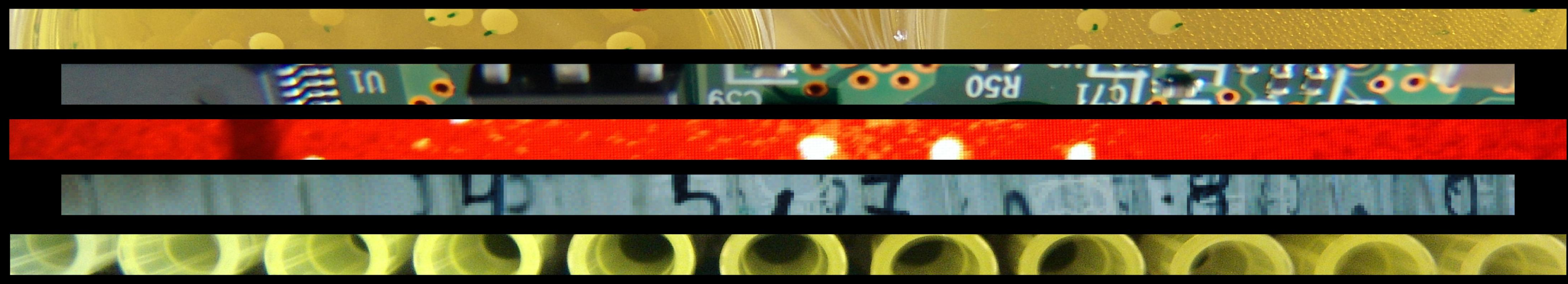

REACTIVITY OF POTENTIALLY TOXIC ELEMENTS IN URBAN AND INDUSTRIAL SOILS: A COMPARISON STUDY

C. Coelho[1], N. Cruz[1], T. Teixeira[1], M. Dias[1], B.Henriques[1], A. C. Duarte[1], S.M. Rodrigues[1*], E.Pereira[1], Paul F.A.M. Römkens[2]

[1]CESAM & Departamento de Química, Universidade de Aveiro, 3810-193 Aveiro, Portugal (*corresponding author: smorais@ua.pt)
[2]Alterra – Wageningen University and Research Center, PO Box 47, Wageningen, 6700 AA, the Netherlands

INTRODUCTION

Accumulation of potentially toxic elements can reach significant levels in soils from urban and industrialized areas, affecting the ecosystems ansd human health.
Total element concentration in soils includes an inert and a reactive fraction that represents the sorbed elements that react with binding sites of soil organic carbon, amorphous metal oxides and clay surfaces (Rieuwerts and al., 2006; Römkens et al., 2009). This reactive fraction is relevant because represents the pool of potentially toxic elements that is in equilibrium with the soil solution and therefore may become available for uptake by organisms and plants (Rodrigues et al., 2010).
In this study, the reactivity levels of As, Ba, Cd, Cr, Cu, Ni, Pb and Zn measured in soils fron urban settings are compared with those from an widely industrialized area.

60 soil samples collected in two distinct areas:

- Porto (Urban area): 18 sampling points (0-10 and 10-20 cm depth)
- Estarreja (Industrial area): 12 sampling points (0-10 and 10-20 cm depth)

ALL SAMPLES WERE COLLECTED IN FIELDS BEING USED FOR AGRICULTURE / PASTURE.

Soil samples → Air –dried and sieved →

- Soil properties
  - pH (ISO 10390/1994 procedure)
  - organic and total carbon content (ISO 1069/1995 procedure)
  - clay fraction (laser diffraction)
- Pseudo-total contents of potentially toxic elements by *aqua regia* digestion and analysis by IPC-OES
- Reactive contents of potentially toxic elements by 0.43 M HNO_3 extraction and analysis by IPC-OES

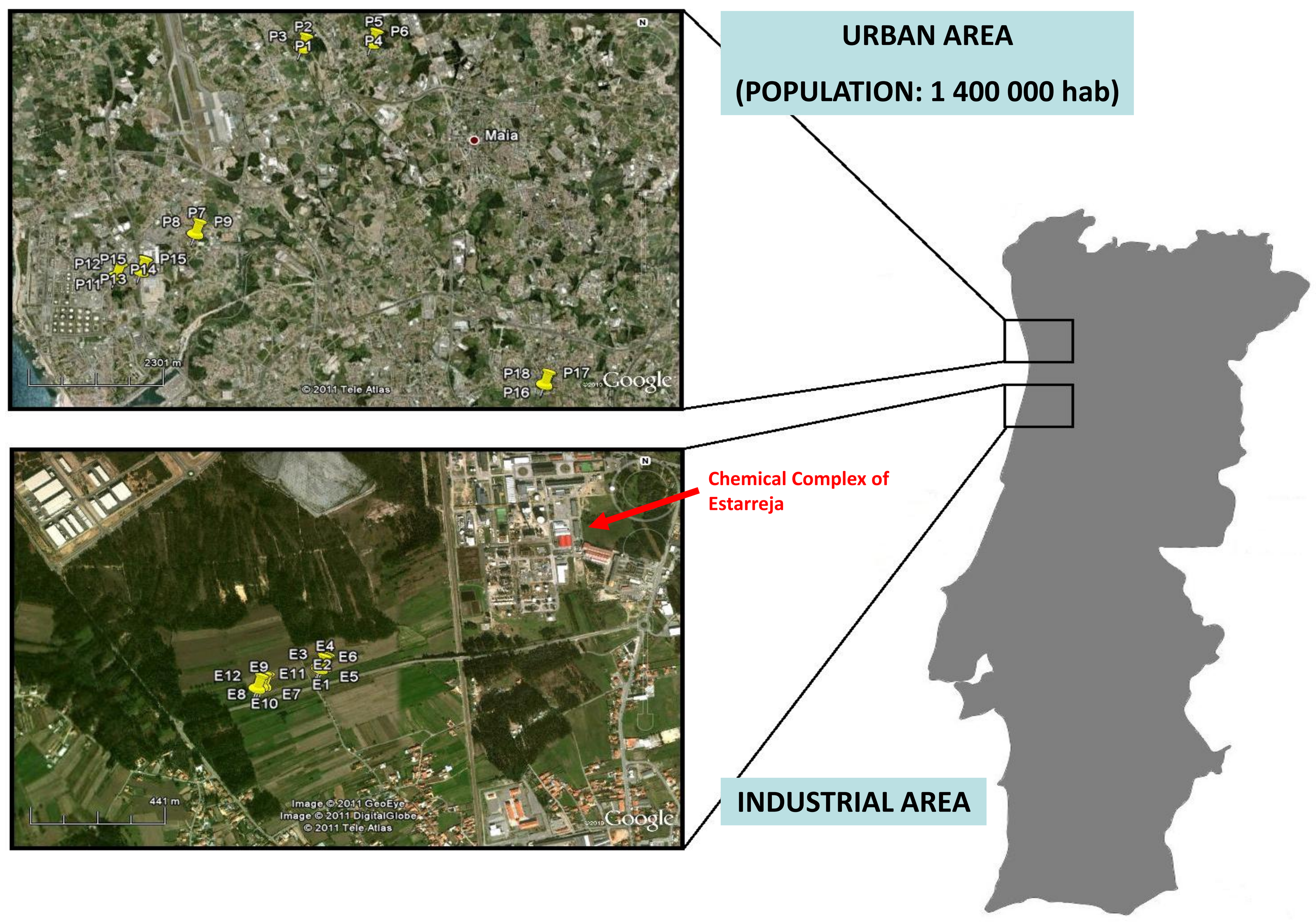

Fig. 1. Geographic location and details of sampling areas.

Concentrations of elements extracted by 0.43 M HNO_3 (reactive pool) in urban and industrial soils

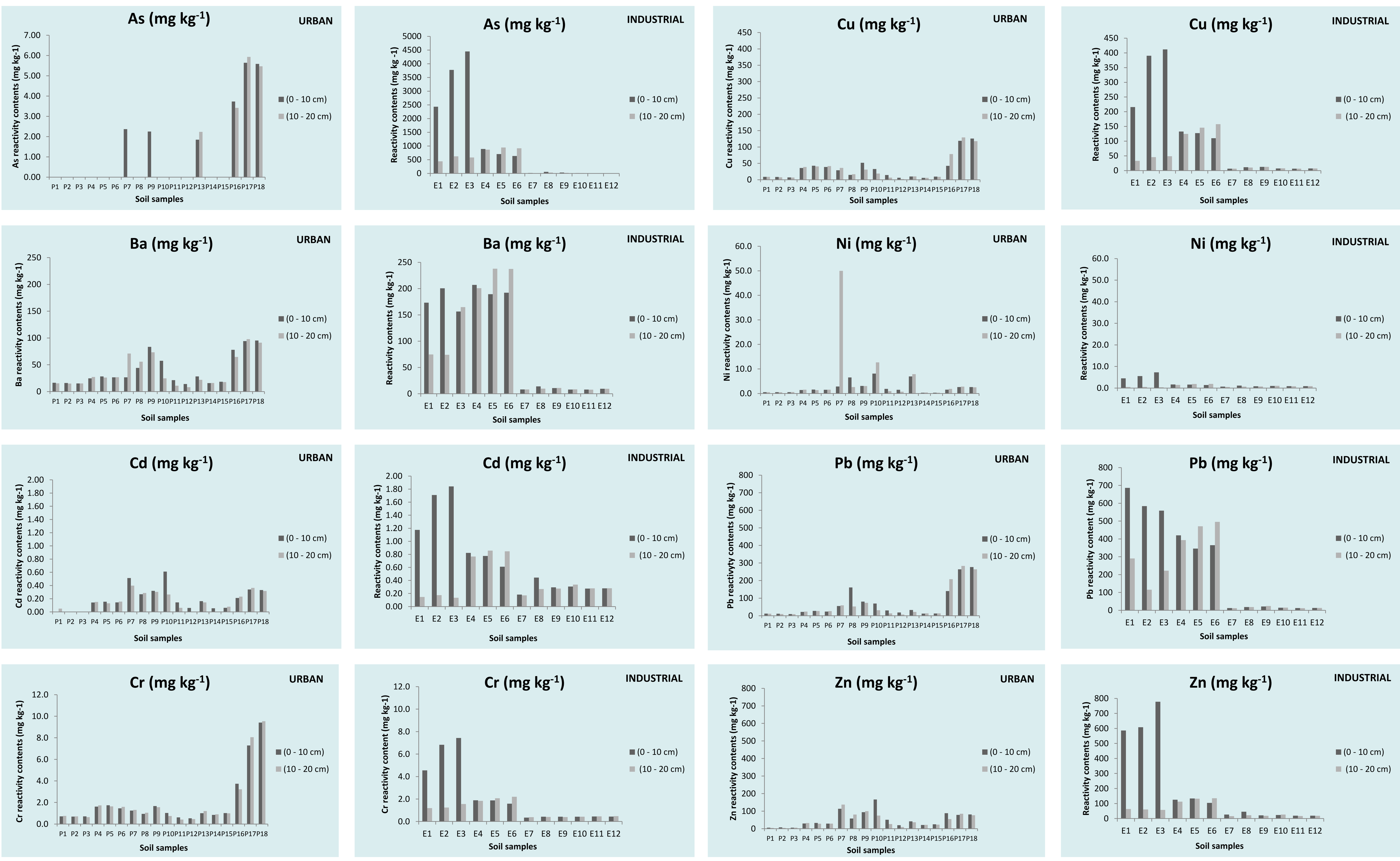

Fig. 2. Reactive contents of As, Ba, Cd, Cr, Cu, Ni, Pb and Zn (mg kg^{-1} d.w.) in urban and industrial soils.

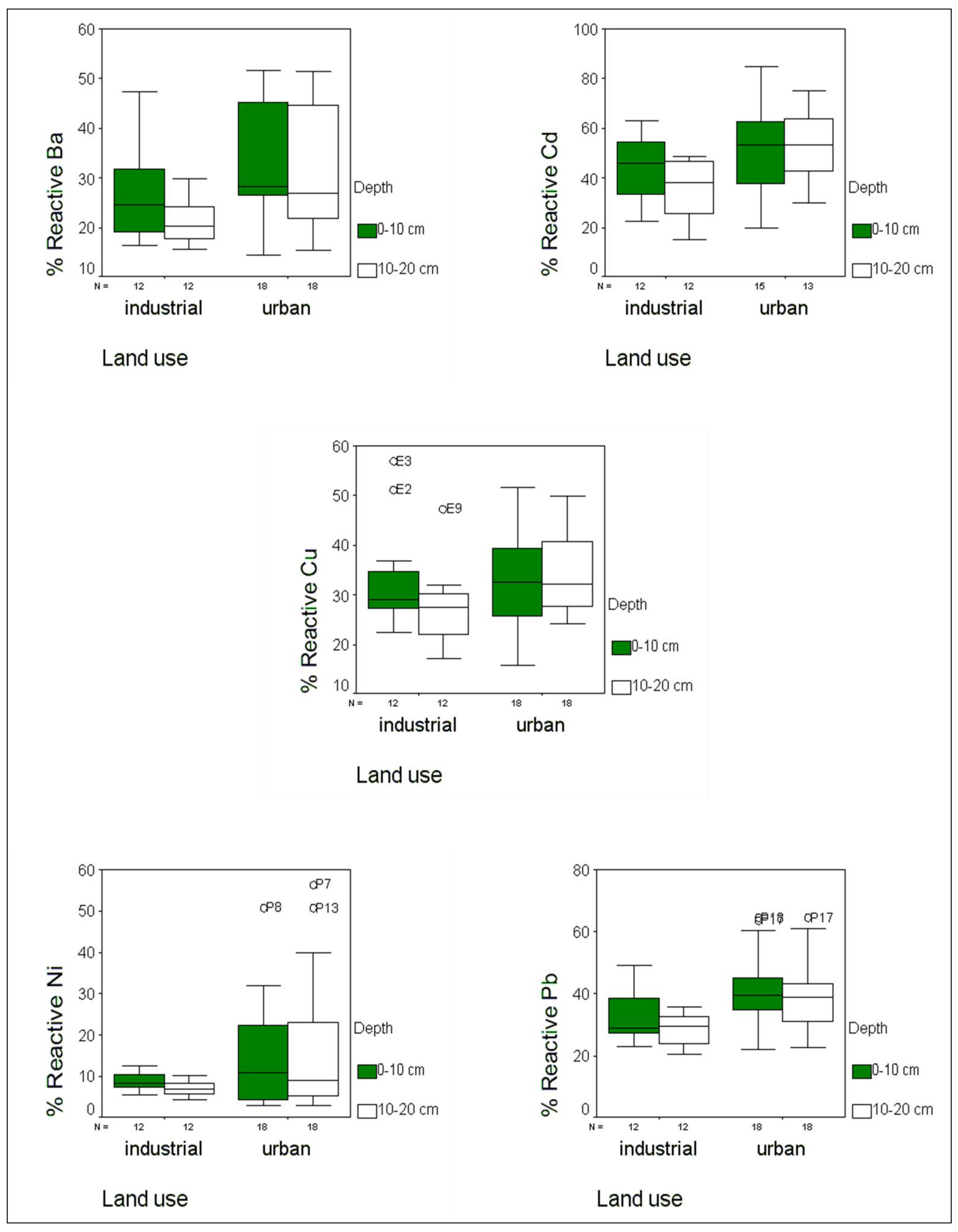

Fig. 3. Box plots of reactive/ pseudo-total ratios (in %) for Ba, Cd, Cu, Ni and Pb in industrial and urban soils (two depths)

CONCLUSIONS

- Higher reactive contents of As, Ba, Cd, Cu and Pb were found in industrial soils when compared with urban soils. This was particularly clear in samples E1, E2, E3, E4, E5 and E6 which were collected in the immediate vicinity of a former effluent stream and were expected to be highly contaminated. Still, relatively high reactive contents of Pb (> 200 mg kg^{-1}) were observed in P16, P17 and P18 in the urban area. It is necessary to assess if this contamination is also affecting crop quality at these sites.
- Reactive concentrations of As in the urban soils were several orders of magnitude lower (< 7 mg kg^{-1}) than concentrations in samples E1-E6 indicating low contamination levels in the urban study area
- Levels of Ni and Cr observed in both settings were generally low and similar. For Cr, levels found in samples P16, P17 and P18 were higher than the remaining urban samples. This appears to be a very localized source but requires further investigation.
- Despite higher reactivity in industrial soils, the ratio reactive/ pseudo-total % for Ba, Cd, Cu and Pb was relatively higher in soils from the urban setting. It is important to further understand the relationship between soil properties (including pH and OrgC content) and this difference.
- The ratio reactive/ pseudo-total % for Ba, Cd, Cu, Ni and Pb in soils from the urban setting was relatively higher in the 0-10 cm layer, compared with the 10-20 cm. It is also important to further understand the relationship between soil properties (including pH and OrgC content) and this difference.

REFERENCES
Rieuwerts *et al.* (2006). *Sci Total Environ*, 366, 864 – 875.
Rodrigues *et al.* (2010). *Chemosphere*, 81, 1549 – 1559.
Römkens *et al.* (2009). *J. Soils Sediments*, 9 (3), 216 – 228.